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The Optimal Commons

Barry C. Field

Much of the work on problems of open-access and common-property natural resources has been focused on deducing and documenting the pathologies of inefficiency to which these resources are prone. Another important job has been deriving policy conclusions; the main one being, perhaps, that productivity will improve in proportion to the speed with which a change is made to individual, or something that behaves like individual, ownership. In making these prescriptions our kit bag of institutional forms contains depressingly few items; in fact, it contains just two: common and individual. We have a situation analogous to one we had in the 1950s, when all goods were divided into two types: private and public. But the space between these two goods types was soon filled in with an infinity of intermediate forms. It is only fair that we fill up the comparable space in the property institutions continuum.

When the first English settlers came to New England in the seventeenth century, they chose to farm much of their land in common. Besides the individually enclosed home lots, these communities at first had common planting fields, common meadows for harvesting hay, and common pastures.¹ Historians differ on why this was so; some take a cultural-capital view that common land use was an institutional holdover from the settlers' land of origin. Others lean toward the position that common land represented an institutional response to the conditions faced by the new settlers. We need not settle this issue here; whatever the correct explanation for this historical fact, it is certainly true that common land use is today totally absent from commercial agriculture in New England.

From these facts we fearlessly deduce that

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¹ These common planting fields are enclosed by a single fence but there are individual tracts within the fence.

between then and now a switch occurred from a system dependent on large amounts of common property to one based exclusively on individual private property. There is interest in knowing when this change occurred; we might like to examine, among other things, the economic forces that led to the change. But if we search through the documents to find the year when the change was made from common to individual in any of the seventeenth and eighteenth century agricultural communities of New England, we would not find it. Instead we would find a transition period during which time the land ownership pattern gradually changed. In some towns the transition was rather rapid, perhaps 60–80 years. In other towns it was slower, taking well over a century. And in Sandwich, Massachusetts, the complete transition took something like 250 years. In the rest of the paper I want to sketch out one possible approach to modeling this phenomenon.

The process of transition consisted of dividing the total land resource into smaller and smaller commons. Assume there are N farmers in a particular community. At one extreme they may all work the total land resource in common; at the other extreme they may designate N separate plots, with each farmer cultivating a plot individually. But there are many intermediate positions. Let m be the number of tracts identified in the community, each to be worked by one or more farmers. Ruling out any reduction in N , then $1 \leq m \leq N$. Any particular value of m between 1 and N gives a mixture of common and individual property; each tract is owned privately by a subset of the N farmers but used by them in common.²

Assume that land institutions currently in use involve a particular value for m ; an increase or decrease in this parameter has three primary impacts on costs and outputs:

(a) *A change in resources devoted to defining and enforcing private rights.* This in-

² Among the Navajos the fenced-in range areas within which several permit holders graze their sheep is a clear example of an intermediate sized commons. See Libecap and Johnson, p. 82.

cludes such things as fencing costs, legal costs to determine title, costs of detecting and stopping encroachments, and so on. Call these exclusion costs.

(b) *Changes in the total value of common-property externalities in the community.* How much change occurs as a result of smaller numbers of firms using each commons is uncertain. In some models of common property, such as that of Dasgupta and Heal, the extent to which the commons is used in excess of the rent-maximizing level depends on the number of users who are allowed access to the resource; the smaller this number the less the overuse, even with no controls on use by individual members of the group. Thus, the larger number of commons areas into which the total land area is divided, the lower the overuse in each area and therefore the lower the aggregate overuse. As m approaches N , the overuse approaches zero. In the recent work of Cornes and Sandler, however, full rent dissipation occurs as long as $n > 1$.

(c) *Changes in transactions costs of reaching x -limiting agreements among users of a commons.* A major factor affecting these costs is simply the number of firms using a commons; thus, as this number declines it should be less costly to reach agreements to limit the quantity of variable input applied to the resource.

It is the balance between common-property externalities, transactions costs, and exclusion costs that determines the optimal commons. Define the following terms:

N is the total number of farmers in the community;

m , the number of commons;

$n (= N/m)$, the number of farmers per commons;

r_i , the amount of land used by farmers in the i th common;

x_i , the amount of variable input used in the i th common;

$F(x, r)$, total output in the i th common; $F_x \geq 0$, $F_{xx} < 0$, $F_r > 0$, $F_{rr} < 0$; F is assumed to display constant returns;

p, w , prices of output and the variable input, respectively;

$T(x, n)$, transactions costs of reaching agreement on levels of x_i , $T_x < 0$, $T_n > 0$; and

$E(m)$, total exclusion costs, $E_m > 0$.

Assuming that all farmers are identical, the total land area will be divided into m commons, each of the same size with the same number of farmers. Under these circumstances, total agricultural rent is

$$Y = m[F(x, r) - xw - T(x, n)] - E(m).$$

The T function is obviously a great simplification of a complex process. Individual reductions in use of a commons are in the nature of public goods, they confer benefit on every firm using the commons, not just to the firm making the reduction. Individual firms are better off to the extent that they can free ride on the reductions of other firms. Free riding could also be expected with respect to sharing the costs of the political skills and enforcement resources required to achieve agreement on reductions in x . For present purposes we assume these processes are solved, much as early club theory assumed away the problem of collecting contributions to the provision of the public good.

Shifts in T function would come about through changes in the technology of group decision making. A reduction in the strength of complementary social institutions (e.g., the church in colonial times) might be expected to shift T upwards. A change from unanimity to majority rules would shift it down. Increases in the heterogeneity of the users of the commons could be expected to shift T upwards, since agreement would become harder to attain.

The exclusion cost function, $E(m)$, shows how total exclusion costs vary with the number of commons. In simplest terms these might be fencing costs, which would increase as the total land area was split into more commons. Exclusion costs, in the case of common resource use, are subject to a strong public-goods type problem. The benefits of excluding others from a resource apply equally to all those who continue to have access. Thus much of the cost of excluding firms may be resources required to deal with free riders.

There are essentially two variables to adjust, finding the optimal number of commons m and then determining the optimal x , or intensity of use in each commons. We take these up in reverse order. Given m , both n and r are fixed, so the condition for optimal x is

$$(1) \quad pF_x - w - T_x = 0$$

Since $T_x < 0$, each commons is used at a point where $pF_x < w$. Figure 1 depicts this solution: F^*_1 shows returns in terms of revenues minus variable cost for a given size of commons, i.e., given r and n ; T_1 shows the transactions costs of achieving reductions in x ; T_1 has been set at zero at the open-access, or zero-return, level of x . It could originate to the

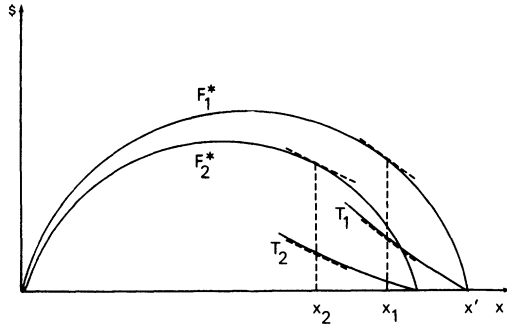


Figure 1. Optimal use rate for a commons

left of this if it were the case that some reduction in x would occur automatically as a result, for example, of particular strategies adopted by the commoners.

The optimal level of x is determined by the tangencies of T and F^* , implying that the extent to which a resource is overused is a function of decision costs. If no effort were made by the commoners to limit their use, x' would be the quantity of variable input applied. But at x' there are returns to be had from making and enforcing x -limiting agreements.

The optimal number of commons can be found with

$$\begin{aligned} \frac{dY}{dm} &= [F(x, r) - xw - T(x, n)] \\ &+ m \left[\frac{\partial x}{\partial m} (F_x - T_x - w) \right. \\ &\left. + \frac{\partial r}{\partial m} F_r - \frac{\partial n}{\partial m} T_n \right] - E_m = 0, \text{ or} \\ (2) \quad &F(x, r) - xw - T(x, n) \\ &+ m \left(F_r \frac{\partial r}{\partial m} - \frac{\partial n}{\partial m} T_n \right) = E_m. \end{aligned}$$

The left side of this last expression is the gain in total rent from a change in the number of commons, while the right side is the change in total exclusion cost resulting from that change. The first three terms on the left side are the total rent earned on the representative common, while the last term is the change in rent on a representative common when the number of commons is changed. The forces tending to change the rent per common are a change in the amount of resource utilized by the common ($\partial r / \partial m$) and its associated impact on output (F_r), together with the change in number of firms ($\partial n / \partial m$) with the resulting impact on transaction costs (T_n). Both $\partial r / \partial m$

and $\partial n / \partial m$ are negative, while F_r and T_n are positive. In figure 1, an increase, say, in the number of commons would shift F^* to F_2^* and F_1^* . Transactions costs would change to T_2 giving a new optimal usage at x_2 . It is possible for the impacts on productivity and transactions costs of changing the number of commons to cancel each other out, leaving rent per common unchanged. In this case total rent would change by virtue of a change in the number of commons.

The condition for the optimal size of m can be depicted graphically. In figure 2, the Z function is the left side of expression (2); it consists of marginal income gains net of marginal transactions costs. Z_1 is an initial situation, showing little income difference between few and many commons; Z_2 , on the other hand, refers to a later time when, because, say, of rising heterogeneity among farmers or a decline in the strength of complementary social institutions, a system of smaller commons is capable of producing much larger net rents than one of larger commons. The E functions show how marginal aggregate exclusion costs change with the number of commons; E_1 is the initial condition and E_2 refers to a new situation in which because, say, of technological change in fence construction or the development of a more efficient technique for detecting trespassers, marginal exclusion costs do not rise as fast with an increase in the number of commons as was initially the case. As drawn, the optimal commons moves from m_1 to m_2 between these two periods. How fast and far the optimal commons changes through time is apparently a function of the shapes of E and Z , as well as the speed with which they shift.

There is no doubt that other approaches could be taken to finding the optimal degree of

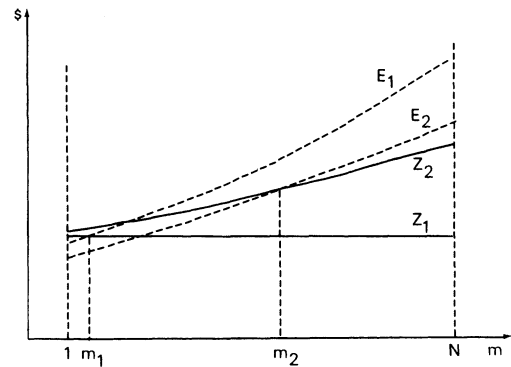


Figure 2. Optimal number of commons

commonness for using a particular natural resource. The important point is that we have a continuum of land-use forms, not just two discrete types. While much of history may have produced changes in factors such that progressively smaller commons have been called for on efficiency grounds, there may have been situations, such as the early agricultural settlements of New England, where the movement was in the opposite direction.

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